



# **Armed Forces College of Medicine AFCM**



# **Male Genital System**

## **I**

**(Semineferous  
tubules)**

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# INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

**1- Describe the microscopic structure of the testis (seminiferous tubules, Sertoli cells) by LM & EM**

**2- Correlate the microscopic structure of the different cells of the seminiferous tubules to their function.**

**3- Discuss the steps of spermatogenesis and spermiogenesis**

**4- Interpret the histological changes in the testis**

# Lecture Plan



1. Part 1 (5 min)
2. Part 2 (35 min)
3. Part 3 (5 min)
4. Lecture Quiz (5 min)

# Male reproductive system



1- **Testis** (sperms & testosterone)

2- **Duct System**

1- Straight tubules

2- Rete testis

3- Efferent ductules

4- Epididymis

5- Vas deferens

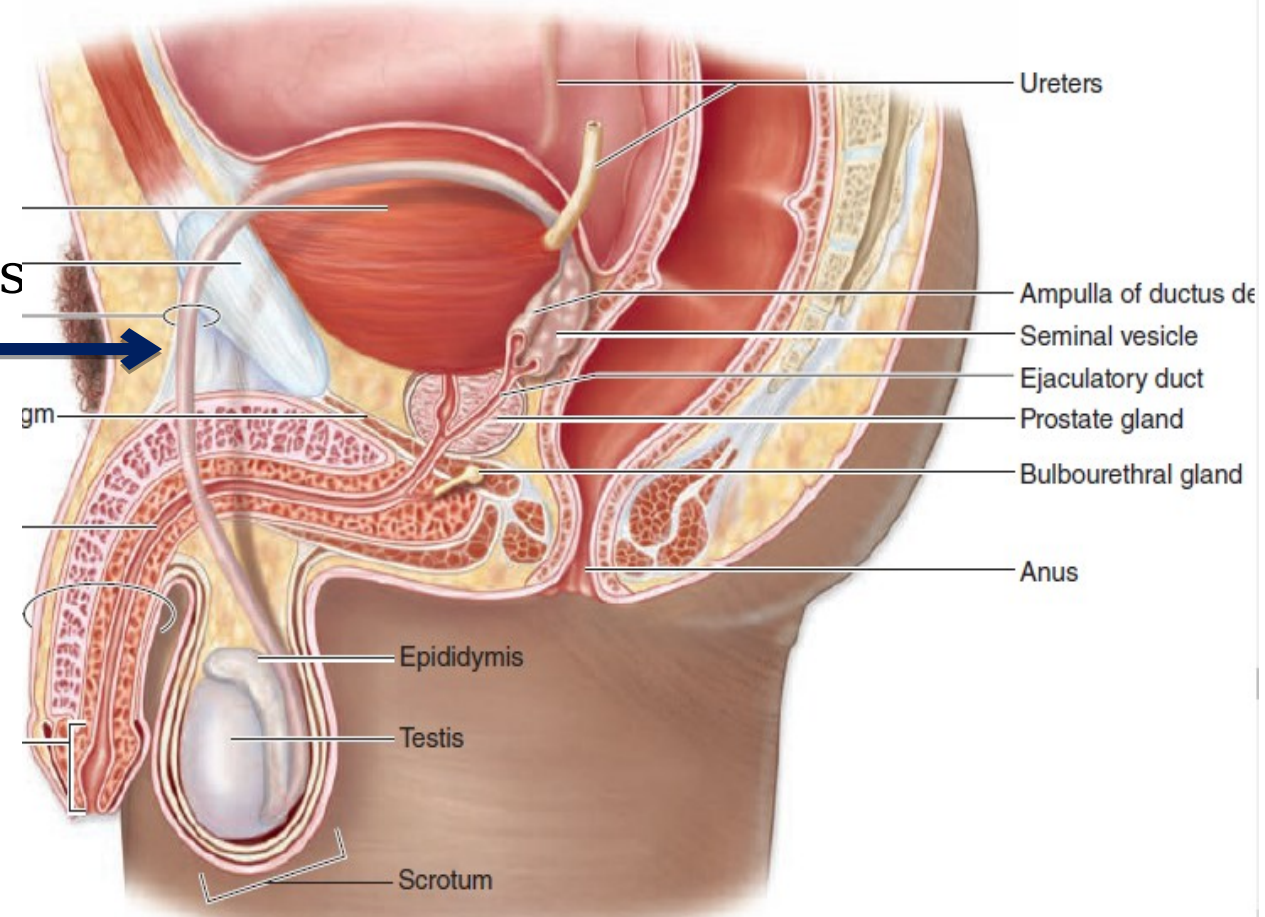
3- **Accessory organs**

1- Prostate

2- Seminal vesicles

3- Bulbourethral gland

4- **Penis**



# Testis

Site: **outside** the body in the scrotal sac

Shape: **oval**

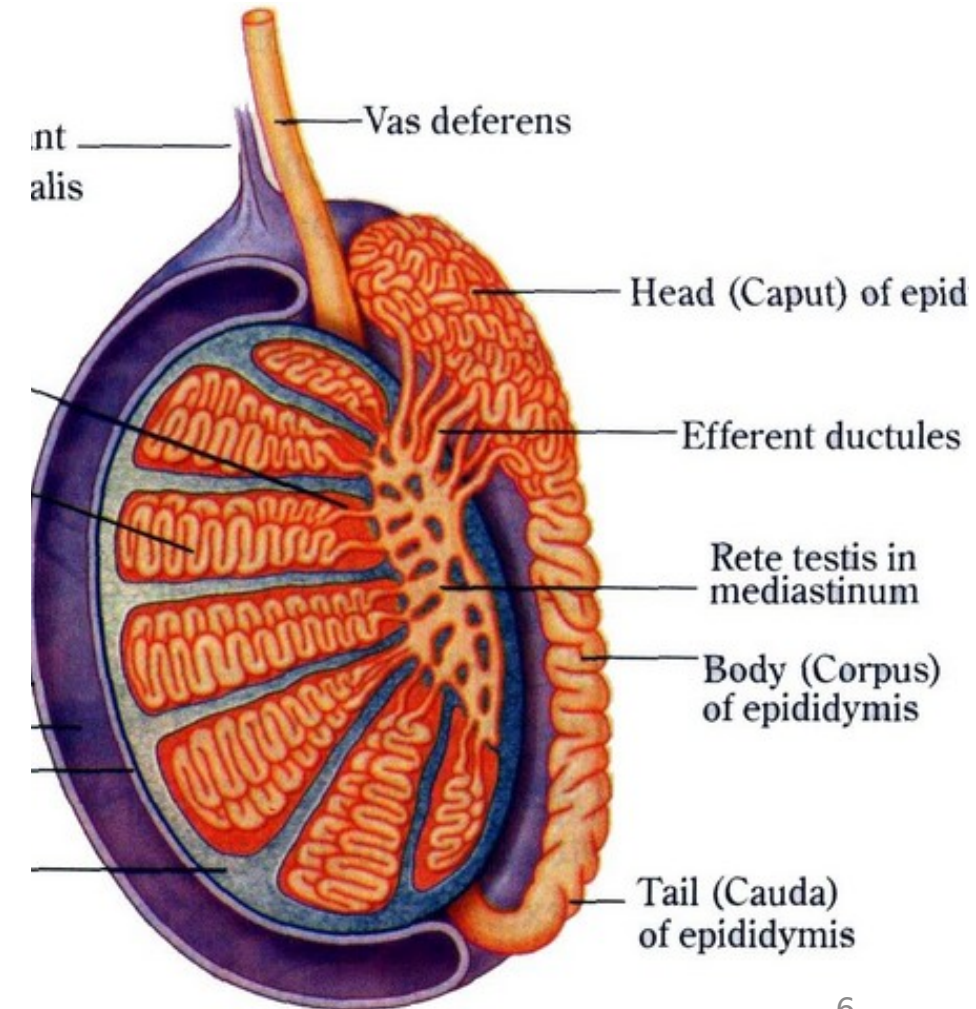
Testis is a **mixed** gland  
**Endocrine**      **Exocrine**  
 Testosterone      Sperm

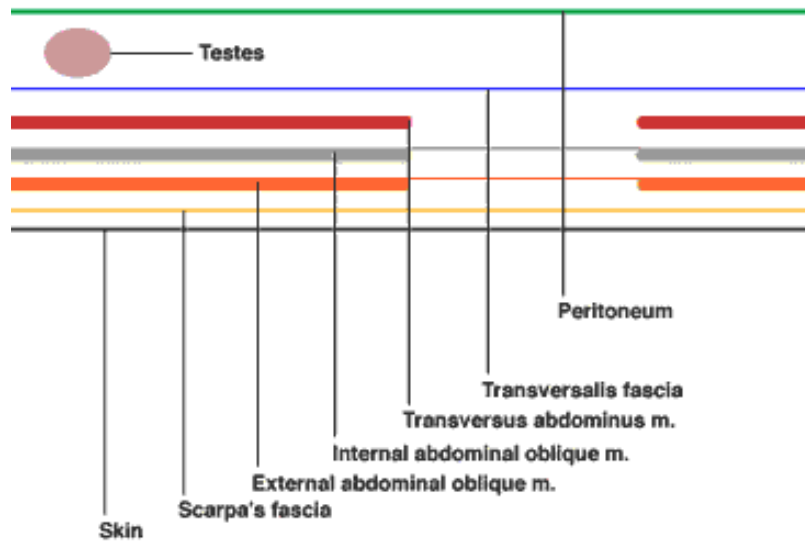
Testis is surrounded by 3 layers

- 1- **Tunica vaginalis**

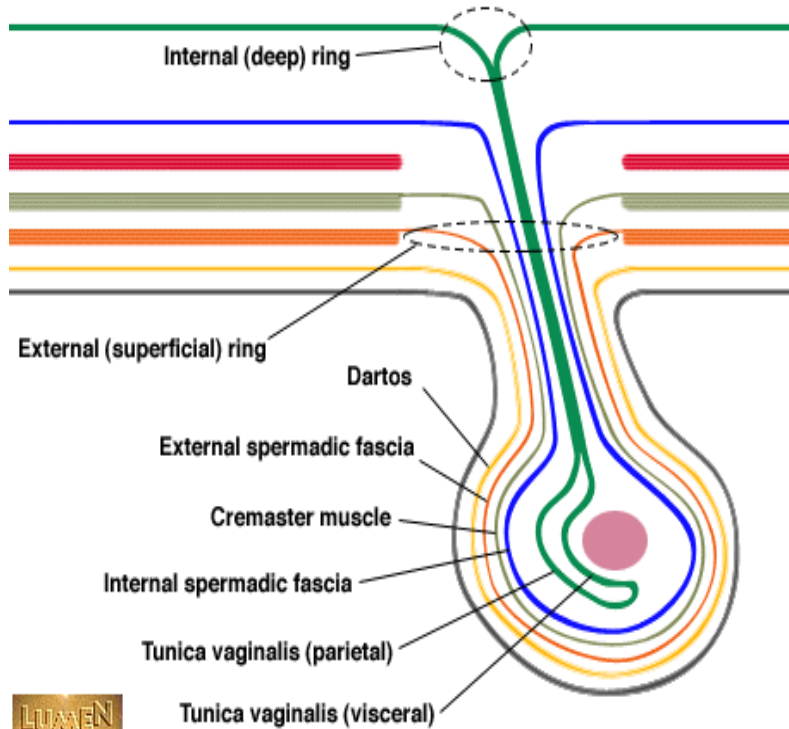
- 2- **Tunica albuginea**

- 3- **Tunica vasculosa**

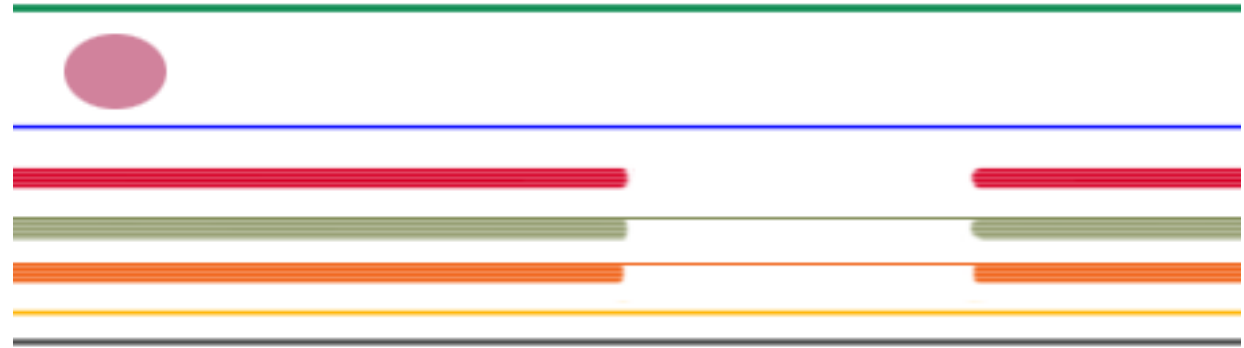




LUMEN



LUMEN





# Testicular coverings



## 1- Tunica vaginalis

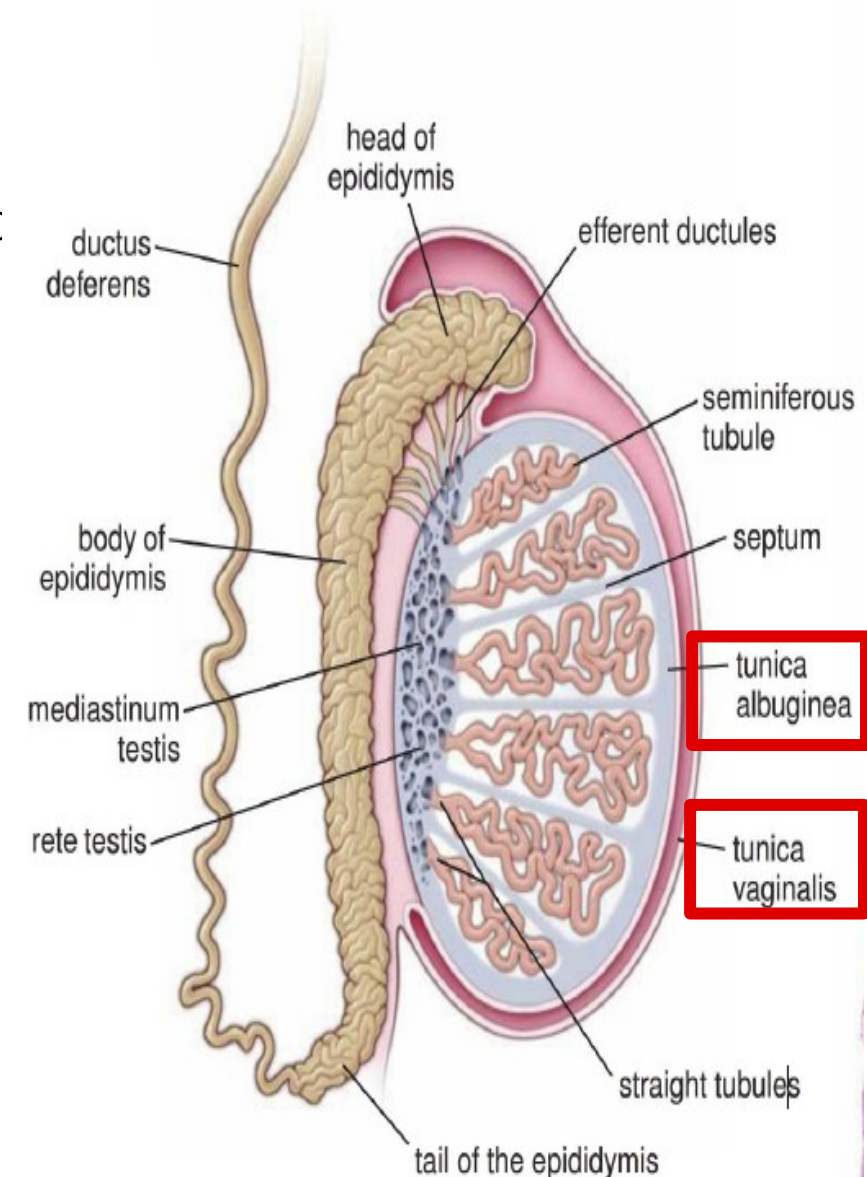
Outer parietal layer & inner visceral layer c  
peritoneum serous sac

## 2- Tunica albuginea

- Packed **collagen fibers** & elastic fibers.  
thickens posteriorly forming **mediastinum**  
**testis** **septa** arise divide the testis into about 250  
compartments (**lobules**)

## 3- Tunica vasculosa

Loose C.T. rich in blood vessels



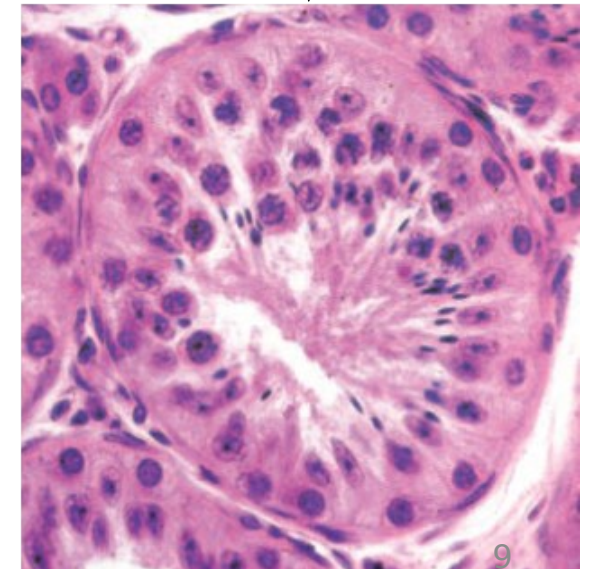
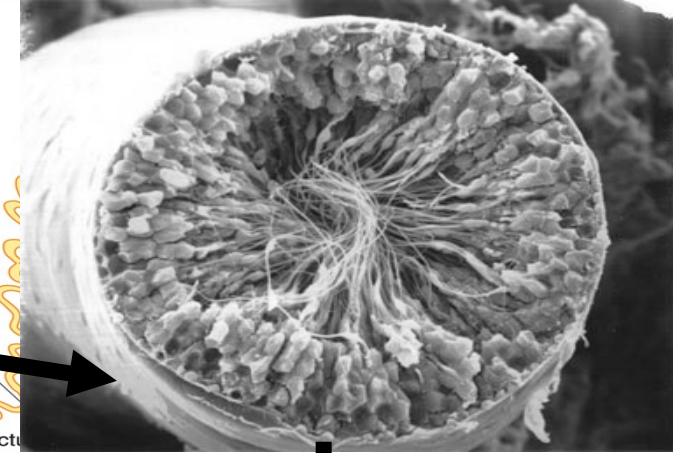
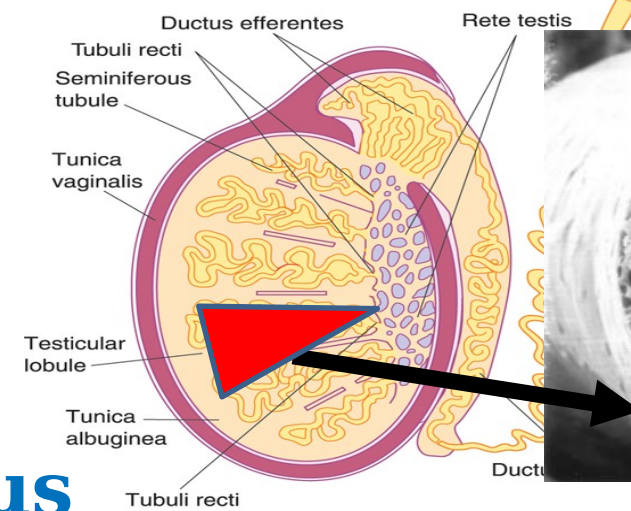


# Testicular lobules

## 250 lobules

Each lobule contains:

- a) 1-4 highly convoluted **seminiferous tubules** for sperm production
- b) Sparse connective tissue containing endocrine **interstitial cells** (or **Leydig cells**) secrete testosterone



# Semineferous tubules



- **Shape:** highly coiled
- **Size:** 30-70 cm in length, 150-250  $\mu\text{m}$  in diameter.
- **Surrounded** by a basement membrane that is surrounded spindle shaped **myoid cells**.



Myoid cells are **contractile** helping spermatozoa & testicular fluid **to move**.

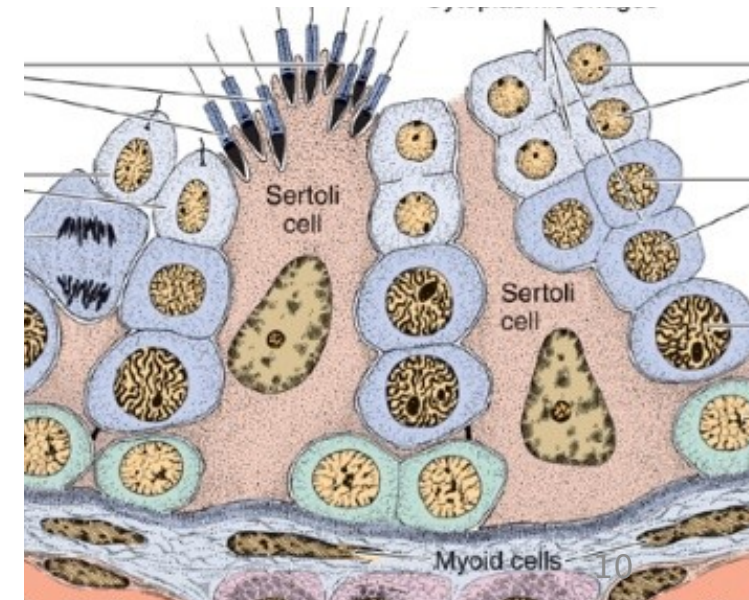
- **Lined by:**

**Spermatogenic cells**

Germinal epithelium;  
various stages of sperm  
formation

**Sertoli cells**

Supporting  
**Non-dividing**



# Sertoli cells



- **Number:** few

**But**

Sertoli cells is the main type of cells until puberty. After puberty, they form 10% of cells lining seminiferous tubules.

Sertoli cells do not replicate after puberty

- **LM:**

➤ **Site:** rest on the basement membrane of seminiferous tubules and extend to their

➤ **lumina.**  
**Shape:**

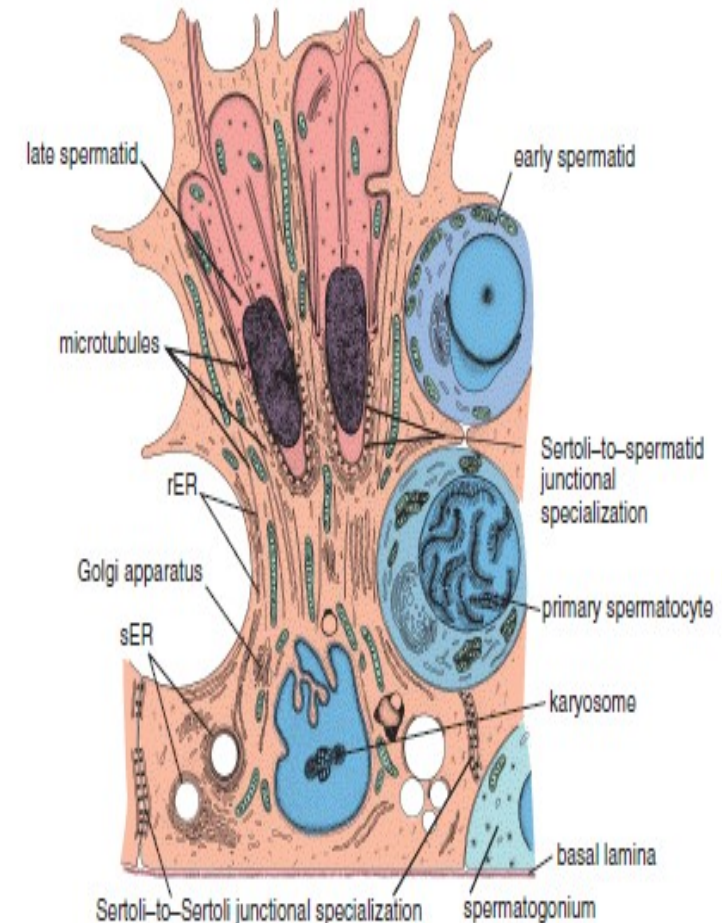
**Tall columnar** cells with **irregular indistinct** cell boundaries.

**Apex is highly folded** contain head of spermatozoa.

**Cytoplasm:** **pale acidophilic**  
**Nucleus:**

**Large intended basal oval, vesicular**

Plasma membrane of Sertoli cells have



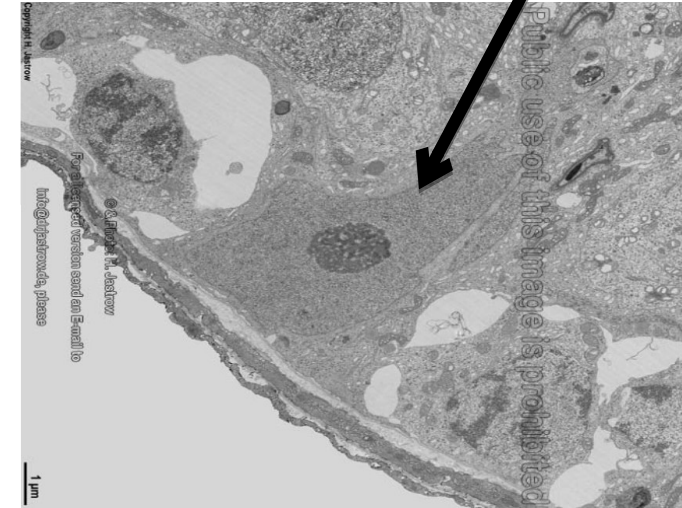


# Sertoli cells



## ▪ EM:

- Abundant **SER**
- **RER** & well-developed **Golgi complex**
- Numerous **mitochondria**
- **Lysosomes**
- Free ribosomes,
- Lipid droplets, glycogen



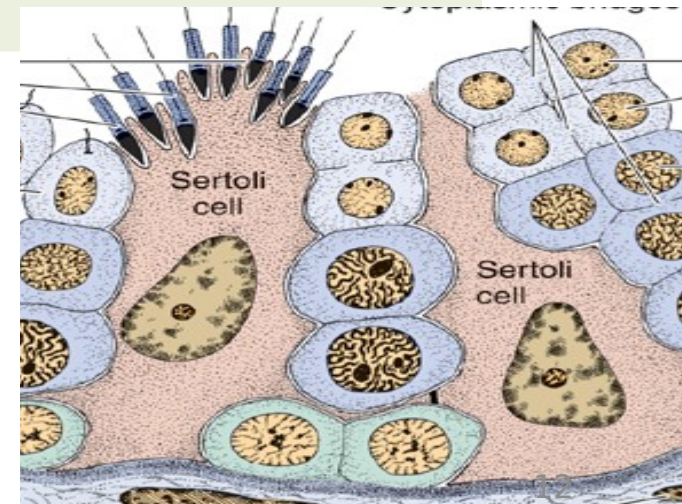
Cell membrane shows **pockets** where the developing spermatogenic cells are present.

## Abundant cytoskeleton of a meshwork of

- **Actin** filaments
- **Intermediate** filaments
- **Microtubules**

For **changing** the **shape** of Sertoli cells which helps in

**movements of germ cells towards the**



# Sertoli cells; Blood-testis barrier



Lateral surfaces of adjacent Sertoli cells form tight junctions  
+ gap junction

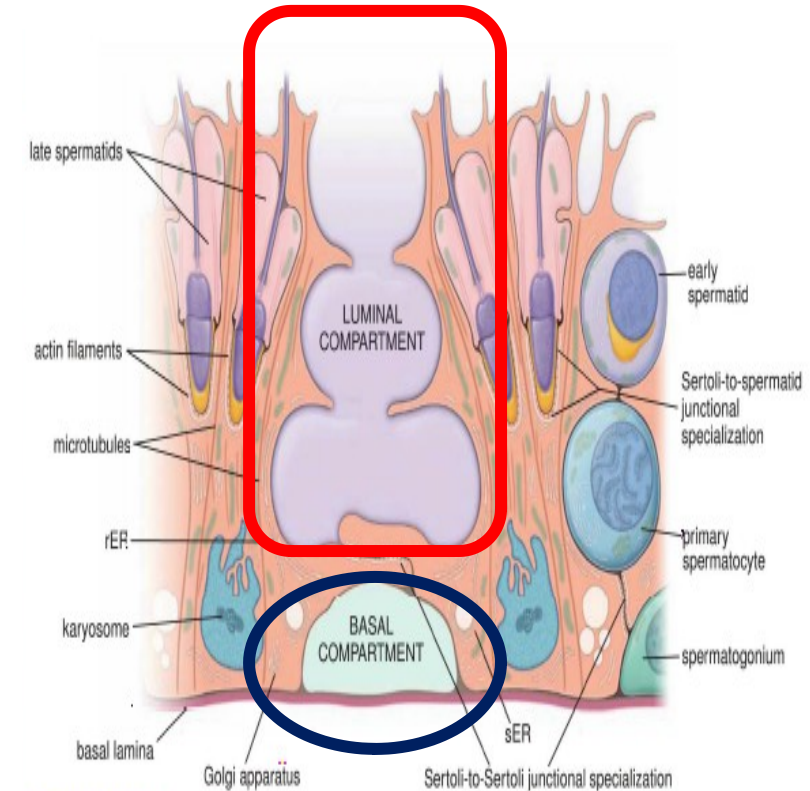
forming blood-testis barrier

1. Basal compartment:  
Narrow & contains spermatogonia.

2. Adluminal compartment: -  
Wider & above the zonula  
occludens  
Contains: primary spermatocytes,

## ➤ Functions

1. Protects the developing gametes from the immune system; it prevents the antigenic properties of sperm from passing to the blood and stimulating an immune response.



# Sertoli cell Functions



**I- Nutritional: fructose-rich fluid** (Nutrition to the spermatogenic cells).

## **II- Exocrine and endocrine functions:**

- 1-Screte **Androgen binding protein** under effect of FSH. It increase concentration of testosterone in testicular fluid which is necessary for spermatogenesis.
- 2- Secrete **Transferrin** to transport iron to maturing gametes, Ceruloplasmin;copper transport.
- 3- Secrete **Inhibin** hormone which inhibits release of FSH.

**III- Phagocytose:** cytoplasmic remnants of spermatids.

## **IV- Support and protection of developing sperms:**

- 1- **Support** and **control movement** of spermatogenic cells present inside surface pockets of Sertoli cells



# E/M and function of Sertoli cells...correlate structure to function??



Structure	Function
sER, rER, golgi complex, mitochondria	<ul style="list-style-type: none"> <li>• <b>Secretion of (exocrine )</b>: testicular fluid, Androgen-binding protein. <b>(endocrine)</b>: inhibin</li> </ul>
Lysosomes	<ul style="list-style-type: none"> <li>• <b>Phagocytose</b> excess spermatid cytoplasm (residual bodies) during spermiogenesis.</li> </ul>
<b>Cytoskeleton</b> : microfilaments & microtubules	<ul style="list-style-type: none"> <li>• <b>Control movements</b> of spermatogenic cells within the seminiferous epithelium and □ the release of spermatozoa in the lumen.</li> </ul>
<b>Tight junction</b> between lateral borders of adjacent Sertoli cells just above spermatogonia	<ul style="list-style-type: none"> <li>• <b>Forming blood-testis barrier</b> Has a role in isolating spermatogenic cells from immune system.</li> </ul>
<b>Gap junctions</b>	<ul style="list-style-type: none"> <li>• <b>Support, protect and nourish</b> spermatogenic cells (provide ionic and</li> </ul>

## **Give reasons:**

- Sertoli cells have lateral pockets.
- Sertoli cells are rich in lysosomes.
- Sertoli cells are rich in RER.
- Sertoli cells are rich in SER.



**What is microscopic structure of the blood-testis barrier?**

.....

.....

**Compare between basal and adluminal compartments of seminiferous tubules.**

**Site: .....**

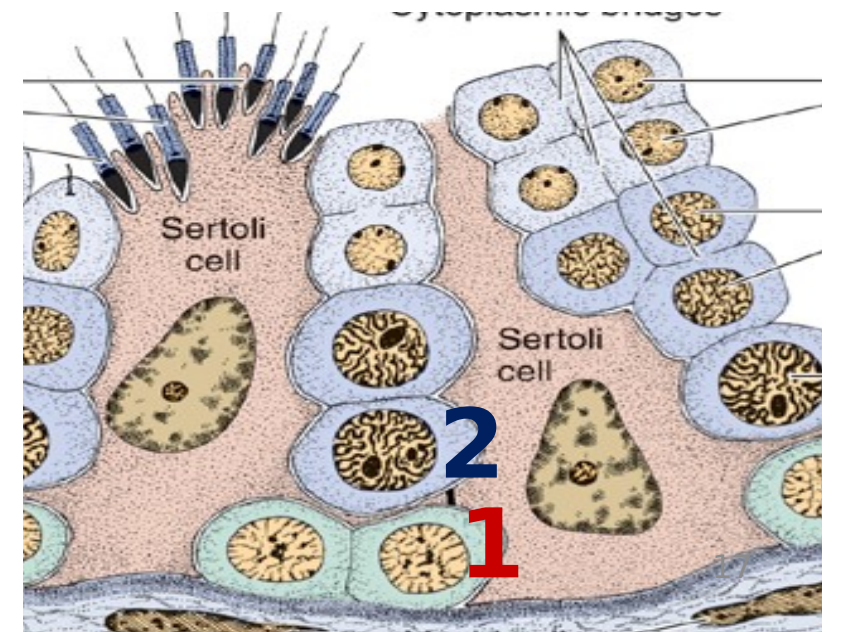
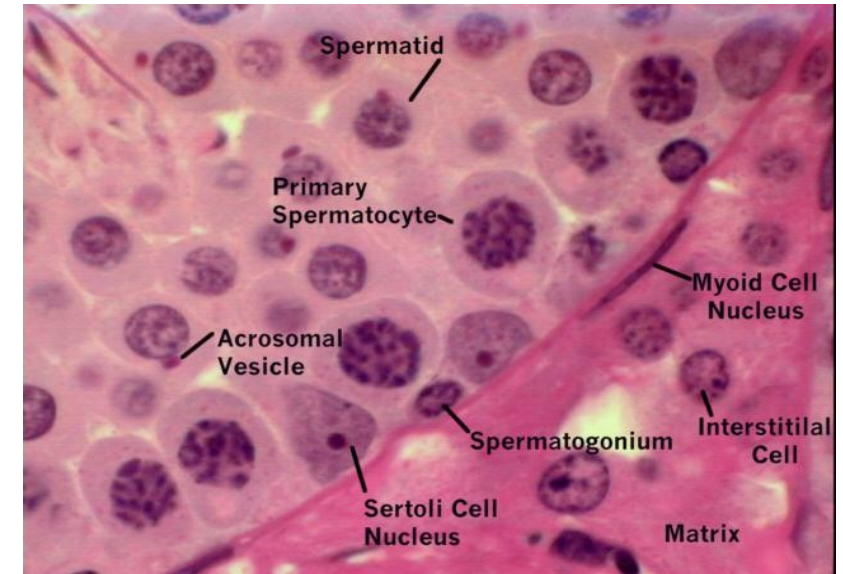
# Spermatogenic cells



**4-8 layers line the seminiferous tubules**

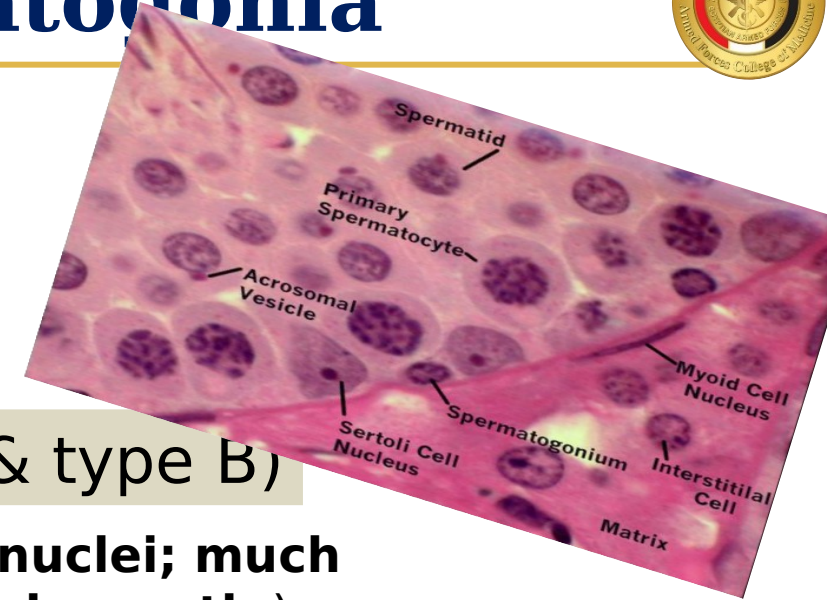
**Spermatogenic cells include:**

1. **Spermatogonia**
2. **Primary spermatocytes**
3. Secondary spermatocytes
4. Spermatids
5. Spermatozoa



# Spermatogenic cells; Spermatogonia

- **Site:** basal compartment of seminiferous tubules



- **Chromosomes:** 44 s-chromosomes (44+XY)

- **Types of spermatogonia:** (type A & type B)

**Dark type A spermatogonia** (Dark nuclei; much heterochromatin)

**Mitosis**

**Dark type A spermatogonia**

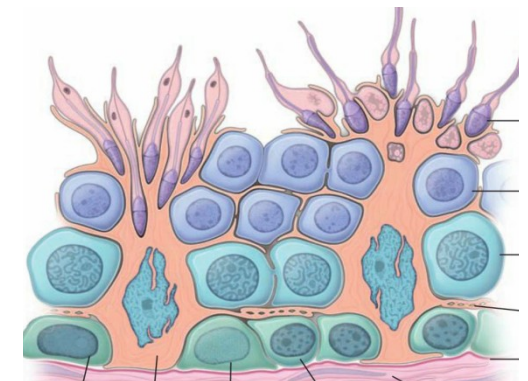
**Pale type A spermatogonia** (transit amplifying progenitor cells)

**Mitosis**

**Type B spermatogonia** (Spherical with pale nuclei)

**Mitosis**

**Primary spermatocytes**





# Spermatogenic cells; Primary spermatocytes

## Primary spermatocytes

(46 d-chromosomes)

First meiotic division



Secondary spermatocytes

23 d-chromosomes

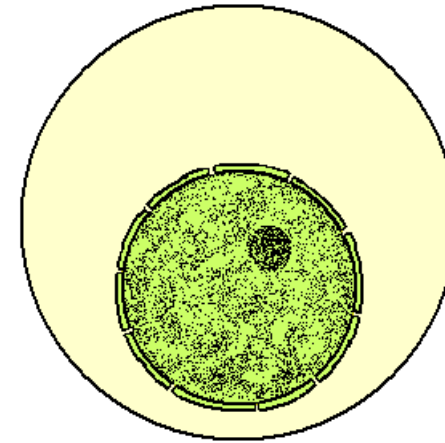
Secondary spermatocytes

23 d-chromosomes

Second meiotic division



Spermatid Spermatid Spermatid Spermatid  
23 s-chromosomes 23 s-chromosomes 23 s-chromosomes 23 s-chromosomes





# Spermatogenic cells; Primary spermatocytes



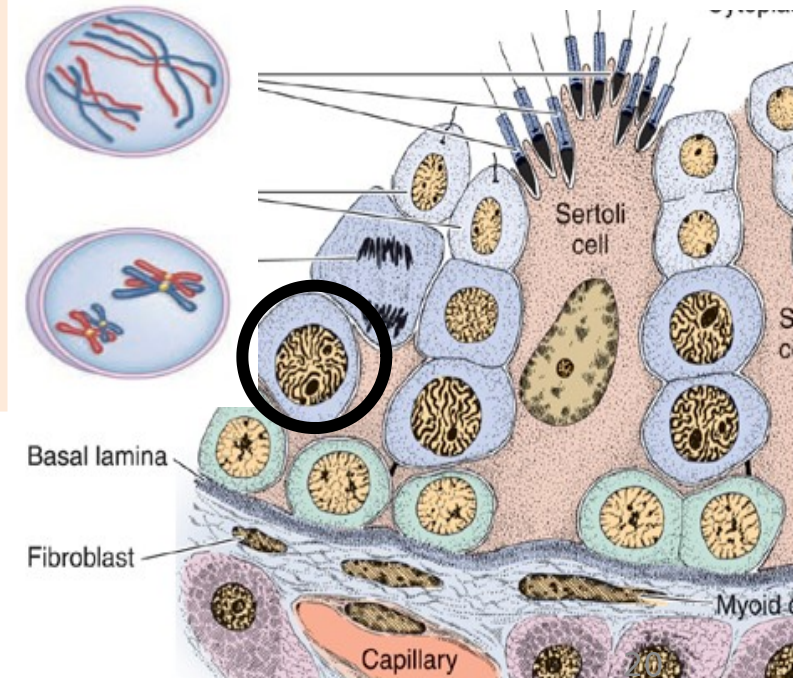
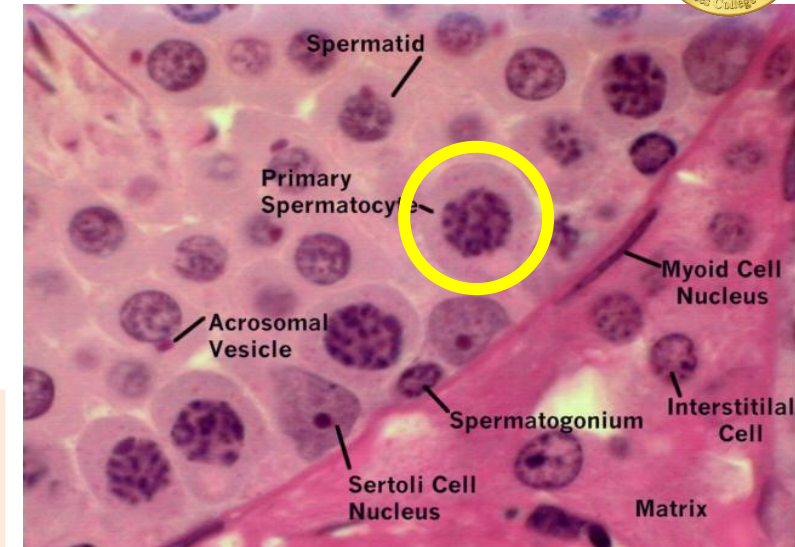
- **Site:** Adluminal compartment.
- **Size:** Largest cell; **16  $\mu\text{m}$**  in diameter
- **LM:** partially condensed chromosomes in various stages of synapsis and recombination

After their formation, primary spermatocytes enter the **S phase** of the interphase of the cell cycle,

**Duplicate their DNA**

**46 d-chromosomes (4n)**

Primary spermatocytes undergo the **first meiotic division** with **prolonged prophase (22 days) showing synapsis & recombination** giving rise to 2 secondary spermatocytes.





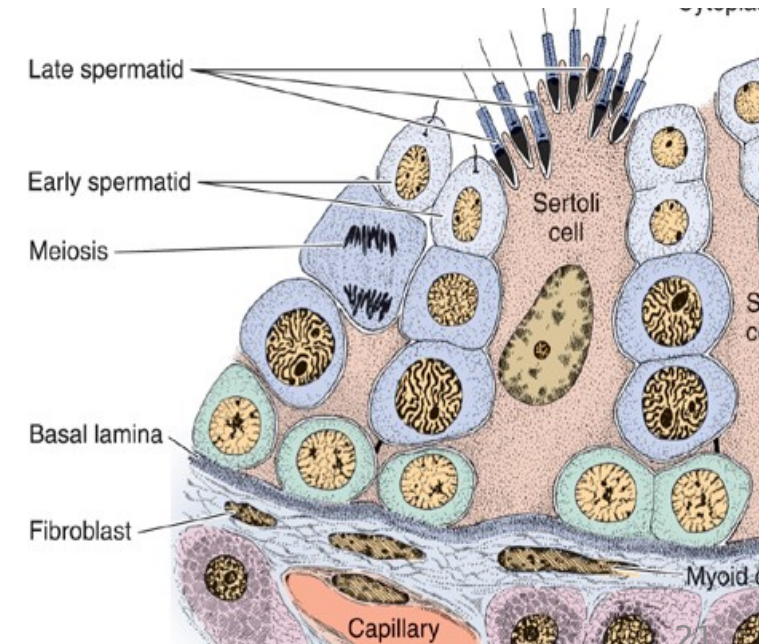
# Spermatogenic cells; Secondary spermatocytes



- **Size:** smaller than primary spermatocytes.
- **Shape:** rounded cells
- **Chromosomes:** Haploid number of chromosomes (23 chromosomes)

They **soon** enter the **2<sup>nd</sup> meiotic division** giving 2 spermatids.

**So, they are hardly seen in a section of testes.**

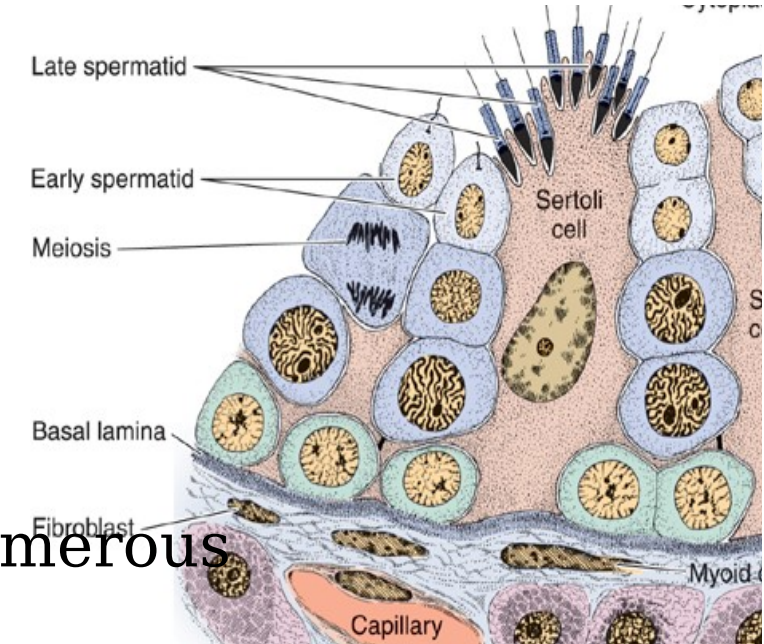


# Spermatogenic cells; Spermatids



- **Size:** Small
- **Shape:** rounded
- **Site:** Near the lumen of seminiferous tubules.
- **Chromosomes:** 23 s-chromosomes (Haploid number)
- **EM:**

Abundant **RER**, well-developed **Golgi complex**, numerous **mitochondria**



**Spermatids do not divide but change by spermiogenesis into spermatozoa.**

# Sperm production (Spermatogenesis)

Sperm production (spermatogenesis) includes:

## 1. Spermatocytogenesis: Formation of spermatids from spermatogonia

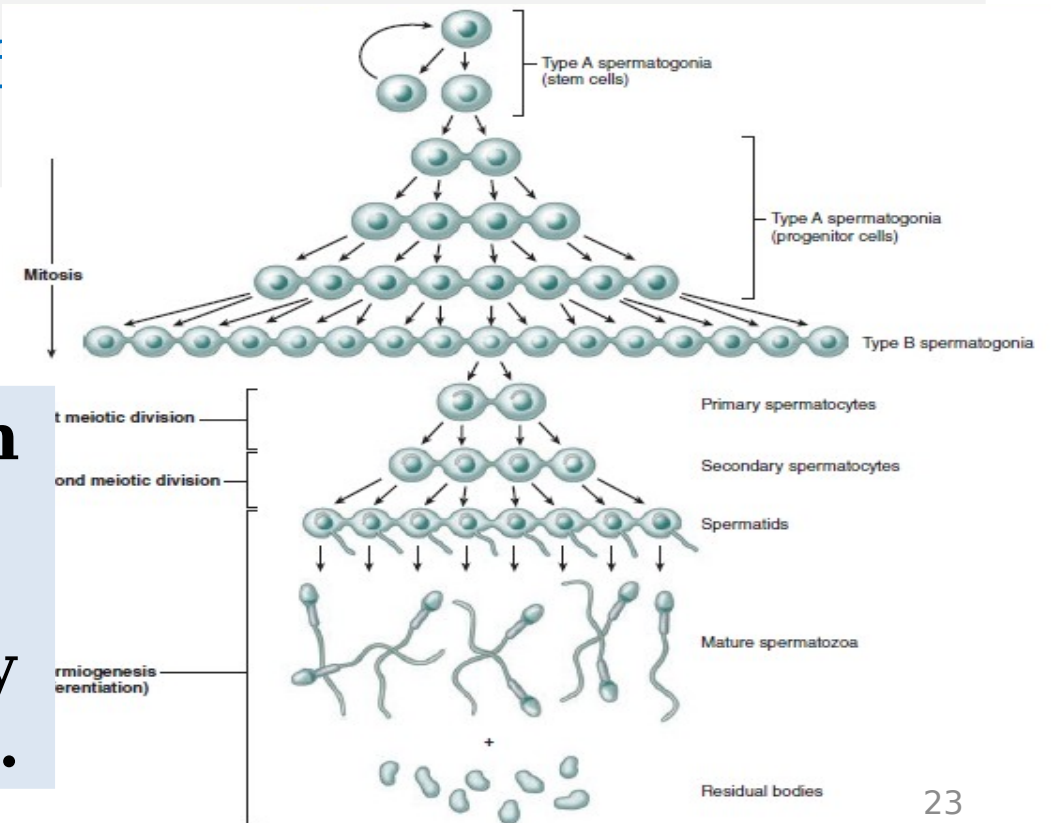
Including **mitosis** of spermatogonia and **meiosis** (1ry&2ry meiotic divisions)

## 2. Spermatogenesis

- Begins at puberty
- Under control of FSH
- Lasts about 2 months

In subsequent divisions, cells remain attached by **Intercellular bridges**

Regulate germ cell differentiation by free diffusion of signaling molecules.

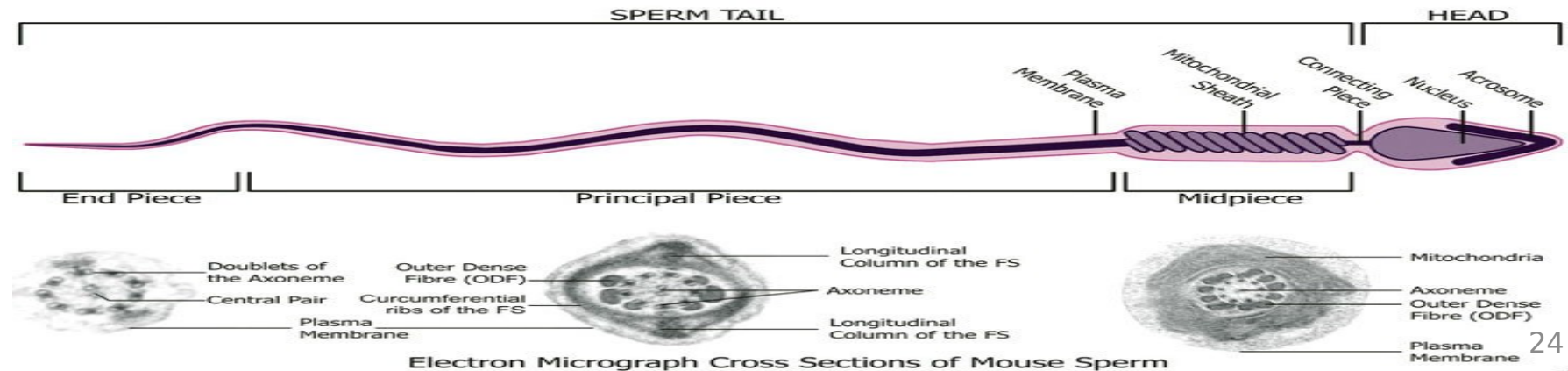
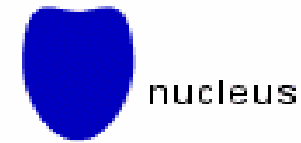


# Spermatogenic cells; Spermatozoa



Sperms arise from spermatids by **spermiogenesis**

- Formed of **head** &
- **Tail** which is divided into:
- ❖ **Neck**
- ❖ **Middle piece**
- ❖ **Principal piece**
- ❖ **End piece**





# Spermatogenic cells; Spermatozoa



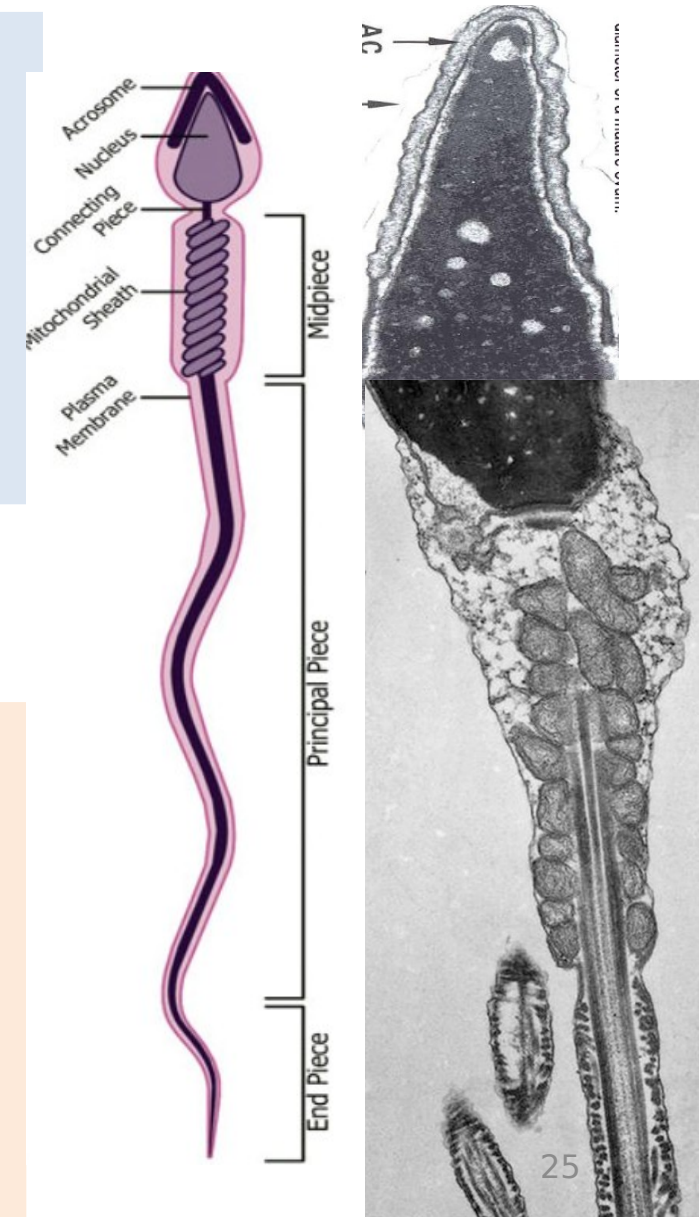
## ❖ Head:

- **Pyriform** in shape, **5  $\mu\text{m}$**  in length
- **Flattened**
- Pyriform nucleus with **condensed chromatin**
- The nucleus is covered at its 2/3 by a cap called **acrosomal cap**.

**Sperms are attached by their heads to the apex of Sertoli cells**

## ❖ Neck: (connecting piece)

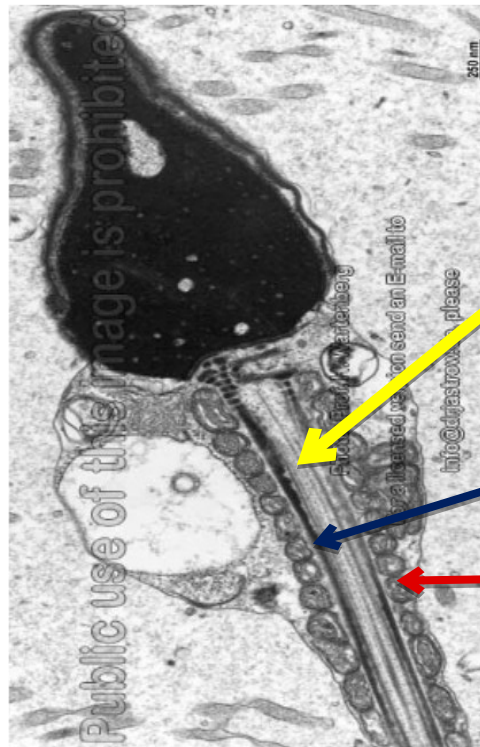
- **Narrow** part connecting the head to middle piece.
- Contains **centriole**.
- Contains the connecting piece formed of **9 fibrous rings**.
- **An axoneme** begins behind the centriole and passes through the middle piece & tail.



# Spermatozoa

## ❖ Middle piece:

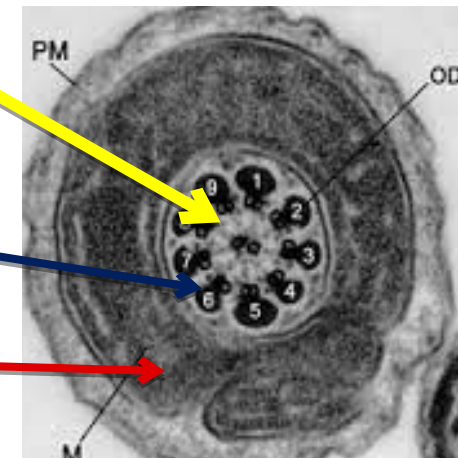
- 5  $\mu\text{m}$  in length
- Contains **axoneme** formed of: 2 central singlets & 9 peripheral doublet microtubules
- Surrounded by 9 fibrous rings & spiral sheath of mitochondria.



2 central singlets & 9 peripheral doublet

9 fibrous rings

Spiral sheath of mitochondria





# Spermatozoa

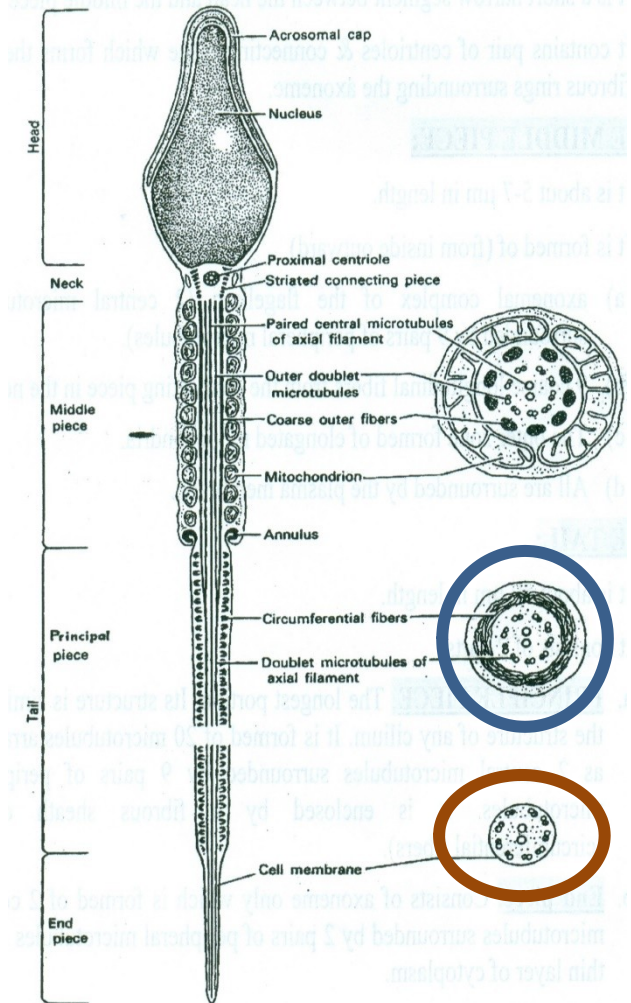


## ❖ Principal piece:

- **Longest**, 50  $\mu\text{m}$  length
- Formed of **2 central singlets and 9 peripheral doublets microtubules**.
- Surrounded by **circumferential fibrous sheath** covered by the plasma membrane.

## ❖ End piece:

- Formed of **2 central singlet microtubules & 9 peripheral doublets** covered by plasma membrane
- In the last 0.5  $\mu\text{m}$ , the **20 microtubules are haphazardly arranged**.



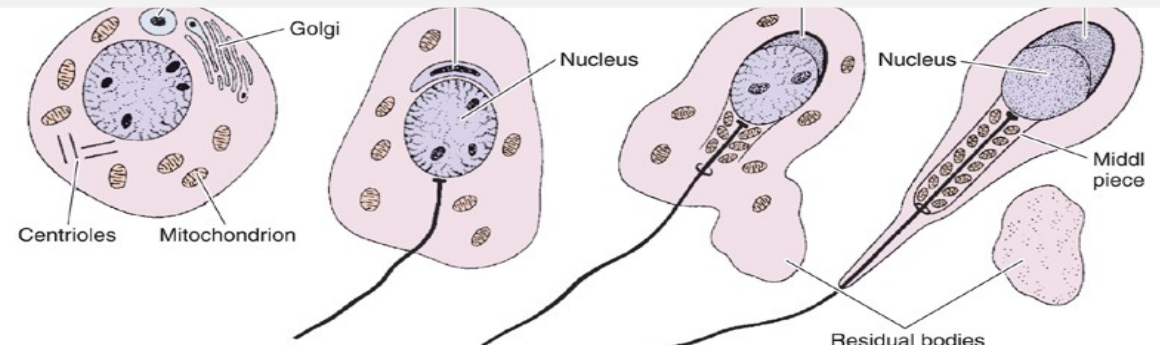
# Spermiogenesis



Process by which spermatid is transformed into spermatozoon  
Temperature sensitive

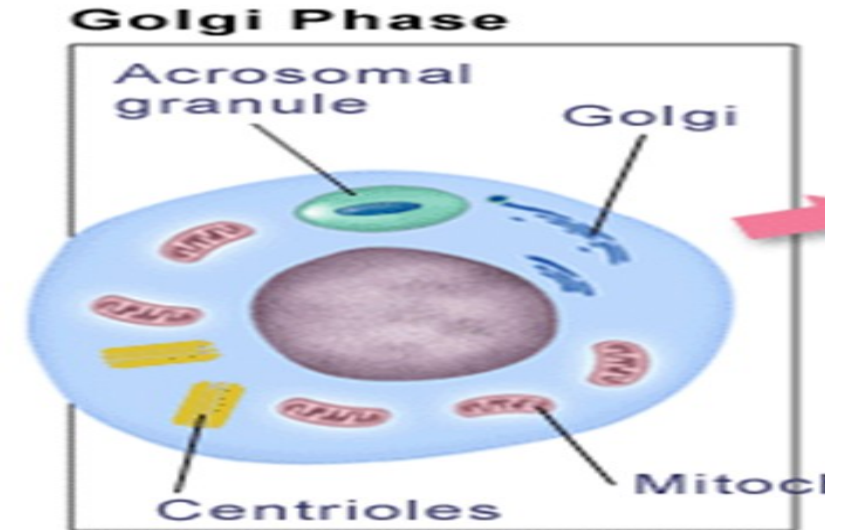
**Includes 4 phases:**

1. **Golgi phase**
2. **Cap phase**
3. **Acrosomal phase**
4. **Maturation phase**



## **1. Golgi phase:**

- Small **proacrosomal** vesicles from the **Golgi** complex **fuse** together forming **a single acrosomal vesicle**.
- **Acrosomal vesicle** binds with the nuclear envelope at the **anterior pole**.
- **Centrioles migrate** back to **posterior**

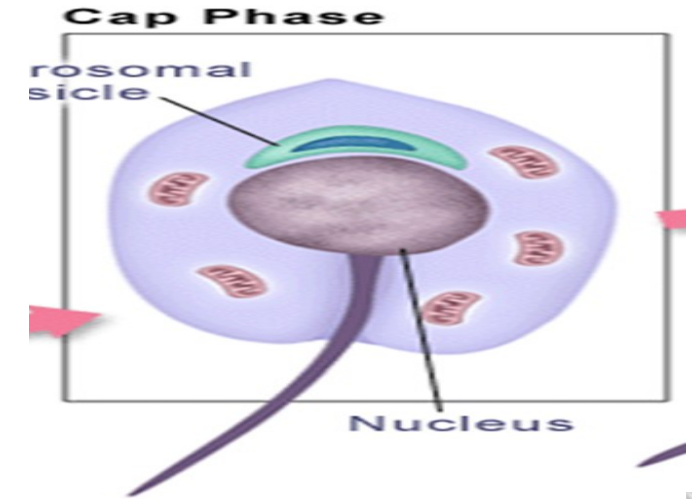


# Spermiogenesis



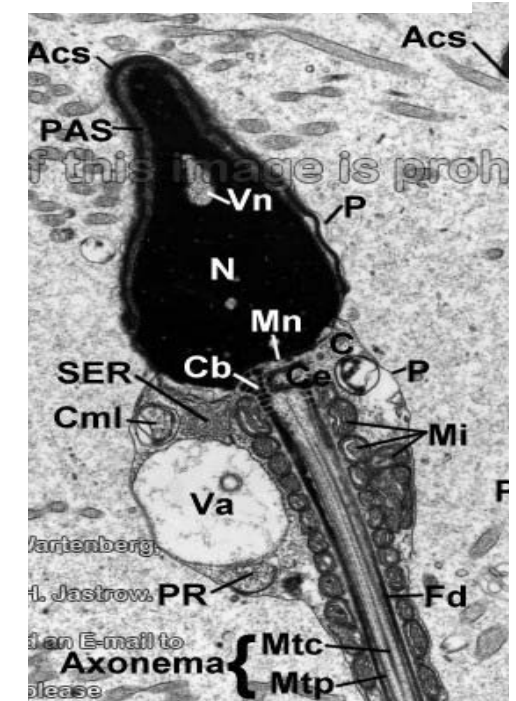
## 2. Cap phase :

- **Acrosomal vesicle** enlarge & surrounds the **anterior 2/3** of the nucleus known as **acrosome** (or **acrosomal cap**)
- Contain **hyaluronidase** and protease called **acrosin**.



## 3. Acrosomal phase :

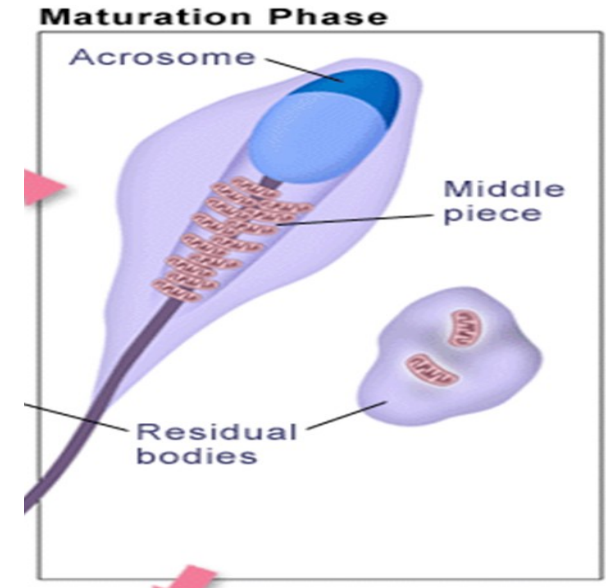
- Cell **elongates**, centriole forms the neck.
- **Axoneme** (9 doublets + 2 singlet microtubules) extends into the tail.
- **9 coarse fibers** develop in the neck region around the axoneme.
- **Mitochondria** become arranged **helically** in the middle piece around the 9 coarse fibers (**mitochondrial sheath**).



**Surplus cytoplasm migrates to posterior**

## 4. Maturation phase:

- Unneeded cytoplasm is shed as **a residual body**
- Remaining intercellular bridges are lost.
- Sperms (fully formed but not functionally mobile) are released into the lumen (**Spermiation**) .



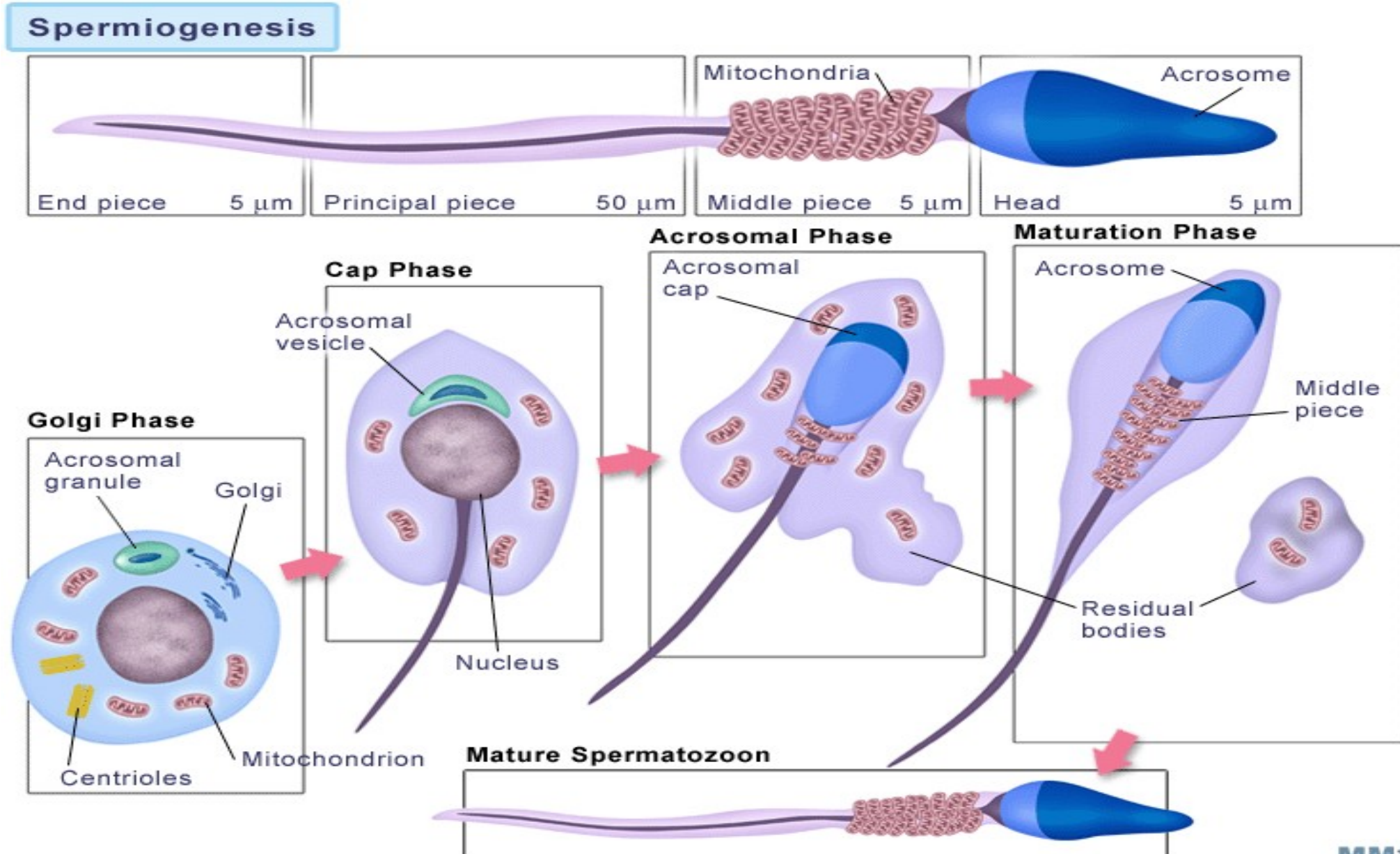
**Formed spermatozoa are immotile & gain motility while passing through the epididymis.**

**Significance of the acrosomal cap:**

Enzymes as protease and hyaluronidase are released when the sperm contact an ovum to facilitate penetration of corona radiata and zona pellucida.



# Spermiogenesis



# Lecture Quiz



**A 26-year-old man presents to the clinic with his wife complaining of primary infertility. His testosterone level is normal. Semen analysis shows no detectable sperm. Testicular fine-needle biopsy demonstrates no detected spermatozoa in the lumen of the seminiferous tubules. The doctor told him that he has a problem in the spermiation with failure of spermatids to separate from which of the following cells?**

- A. Spermatogonia
- B. Sertoli cells
- C. Primary spermatocytes
- D. Myoid cells
- E. Interstitial cells of Leydig



## **SUGGESTED TEXTBOOKS**



- 1. Mescher A (2021): Junqueira's Basic Histology, Text and Atlas. 16th Edition. Lange medical books/Mc Graw-Hill.**
- 2. Michael H. Ross and Wojciech Pawlina (2016): Histology A Text and Atlas:, 7<sup>th</sup> edition.**

THANK

YOU